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THE CONTROL OF THE LESSER PEACH BORER WITH PARADICHLOROBENZENE SOLUTIONS

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CONTENTS

	Page		Page
Introduction.....	1	Further experiments with washes and emul- sions.....	6
Experiments with melted grafting wax and melted paraffin containing paradichloro- benzene.....	2	Comparative effectiveness of paradichloro- benzene dissolved in crude cottonseed oil and in mineral oils.....	7
Experiments with paradichlorobenzene dis- solved in crude cottonseed oil and in soluble pine-tar creosote.....	3	Changes in wash and emulsion during stor- age.....	8
Experiments with paradichlorobenzene in a cottonseed-oil emulsion and dissolved in linseed and corn oils.....	4	Recommendations.....	9
		Summary.....	10

INTRODUCTION

The lesser peach borer (*Synanthedon pictipes* G. and R.) was first described in 1868 by Grote and Robinson,¹ but was not considered a pest of much economic importance until 1906, when Quaintance² reported that it had caused considerable injury to peach trees in Georgia. Since that time it has been regarded as an important peach insect, and during recent years it has caused much damage to some peach orchards. The insect has a decided preference for peach trees, which are its favored host, although other known food plants are plums and cherries (both cultivated and wild), the black-knot fungus (*Plowrightia morbosa* (Schw.) Sacc.) on plum and cherry, juneberry, beach plum, and chestnut.³

The lesser peach borer invariably works in areas on the trunk or limbs of peach trees that have been injured by implements, harness chains, low temperatures, cankers, or sun scald, and in crotches or under loose bark of old trees. (Fig. 1.) Orchards that have been somewhat neglected or those in which there are injured or diseased trees are more subject to attack. Injury is due to the destruction of the cambium and inner bark layers by the feeding of the larvae, and usually a considerable quantity of gum is found exuding from infested areas. In severe cases limbs may be entirely girdled and killed, or the trunk may be honeycombed by the work of the larvae, and in practically all cases the trees are weakened. Such injury is largely confined to old trees since the larvae apparently prefer to work in areas where the bark has been injured in various ways, and at old crotches.

The only control for this insect has been to cut the larvae out of their burrows with a knife, but as hand-worming is unsatisfactory, and

¹ GROTE, A. R., and ROBINSON, C. T. DESCRIPTIONS OF AMERICAN LEPIDOPTERA.—NO. 4. Amer. Ent. Soc. Trans. 2:179-206, illus. 1868. (See p. 182-183.)

² QUAINANCE, A. L. THE PRINCIPAL INSECT ENEMIES OF THE PEACH. U. S. Dept. Agr. Yearbook for 1905: 325-348, illus. 1906. (See p. 335.)

³ GIRAULT, A. A. THE LESSER PEACH BORER. (SYNANTHEDON PICTIPES G. & R.) U. S. Dept. Agr., Bur. Ent. Bul. 68, (Pt. 4): 31-48, illus. 1907.

since the trees are seldom killed by the attacks of this insect, even this measure has not been enforced. Consequently, heavy infestations, especially in old orchards, are not uncommon. The absence of an effective and practical remedy for the control of this important peach insect attracted the senior writer's interest in the problem in 1924 when observations and experiments were started. This circular gives



FIGURE 1.—Peach tree attacked by the lesser peach borer. (Note the infested areas on both laterals near the top of the picture.)

the results of experiments conducted at Fort Valley, Ga., during the three years 1928 to 1930, inclusive.

EXPERIMENTS WITH MELTED GRAFTING WAX AND MELTED PARAFFIN CONTAINING PARADICHLOROBENZENE

In 1928 ⁴ experiments with paradichlorobenzene in melted grafting wax and also in melted paraffin ⁵ applied hot were conducted to test

⁴ H. S. Swingle assisted the senior writer with the experiments during the fall of 1928 and spring of 1929. For a further account of those experiments see SNAPP, O. I., and SWINGLE, H. S., PRELIMINARY REPORT ON PARADICHLOROBENZENE SOLUTIONS FOR THE CONTROL OF THE LESSER PEACH BORER, *AEGERIA PICTIPES* G. AND R. Jour. Econ. Ent. 23: 636-638. 1930.

⁵ WILSON, J. W. THE PLUM TREE BORER. S. Dak. Agr. Expt. Sta. Ann. Rpt. 1927: 15-18. 1927.

them as remedies for the lesser peach borer and to note their effect on peach trees. The mixtures were used in the proportion of 4 pounds of grafting wax or paraffin to 1 pound of paradichlorobenzene. They were checked against melted grafting wax and melted paraffin used alone. All of the materials were applied while hot to the infested areas of peach trees with a paintbrush on November 7. No attempt was made to remove the gum or frass or to otherwise expose the burrows of the larvae before the materials were applied. The results of the experiments of 1928 are given in Table 1.

TABLE 1.—*Results of experiments with melted grafting wax and melted paraffin containing paradichlorobenzene for the control of the lesser peach borer, Fort Valley, Ga., 1928*

Materials applied to infested areas of peach trees on Nov. 7	Total number of larvae examined and the per cent found dead on examination after exposure of—							
	1 week		2 weeks		3 weeks		6 weeks	
	Total larvae	Per cent dead	Total larvae	Per cent dead	Total larvae	Per cent dead	Total larvae	Per cent dead
Grafting wax and paradichlorobenzene.....	18	44	24	29	13	39	-----	-----
Grafting wax alone.....	13	0	20	0	10	10	-----	-----
Paraffin and paradichlorobenzene.....	22	55	46	65	33	40	14	86
Paraffin alone.....	11	9	25	0	15	0	21	0

Although these results were promising, it was evident that the application of the materials while hot in peach orchards was not practical, and the method of control would not be popular unless some material not requiring the use of heat to render it fluid were used as a solvent for the paradichlorobenzene. Paradichlorobenzene in grafting wax proved less effective than in paraffin and the wax much more disagreeable to use. The somewhat erratic results were apparently due to the excessive quantities of gum produced by some trees, which closed the larval burrows and prevented the penetration of the insecticide. The average temperature during the first two weeks of the experiment was 57.5° F., and the maximum daily temperature reached 70° or above on only 7 of the first 14 days. Applications a little earlier in the fall might have proven more effective. There was no tree injury from any of the treatments.

EXPERIMENTS WITH PARADICHLOROBENZENE DISSOLVED IN CRUDE COTTONSEED OIL AND IN SOLUBLE PINE-TAR CREOSOTE

In the spring of 1929 experiments were started with paradichlorobenzene dissolved in cottonseed oil for the control of the lesser peach borer, since previous experiments had shown that a remedy which must be applied hot would not be practical in large commercial peach orchards. One pound of paradichlorobenzene to 2 quarts of crude cottonseed oil was used. As Hamilton⁶ had reported good results from paradichlorobenzene dissolved in soluble pine-tar creosote for the control of various boring insects, 1 pound of the chemical dissolved in

⁶ HAMILTON, C. C. SOME TESTS OF PARA-DICHLOROBENZENE DISSOLVED IN SOLUBLE PINE TAR CREOSOTE IN THE CONTROL OF BORING INSECTS IN LIVING PLANTS. N. J. Agr. Exp. Sta. Ann. Rpt. (1926) 39: 196-199. 1927.

1 quart of soluble pine-tar creosote and then diluted with 1 quart of water was also included in the experiments of the spring of 1929. Both solutions were checked against crude cottonseed oil and soluble pine-tar creosote used alone. Melted paraffin containing paradichlorobenzene was used again to obtain additional data on its effectiveness. All the materials were applied to the infested areas of peach trees with a paintbrush on April 2. The results are given in Table 2.

TABLE 2.—*Results of experiments with paradichlorobenzene dissolved in different solvents for the control of the lesser peach borer, Fort Valley, Ga., 1929*

Materials applied to infested areas of peach trees on Apr. 2	Total number of larvae examined and the per cent found dead on examination after exposure of—			
	1 week		2 weeks	
	Total larvae	Per cent dead	Total larvae	Per cent dead
Paradichlorobenzene and crude cottonseed oil.....	10	90	47	98
Crude cottonseed oil alone.....			11	45
Paradichlorobenzene and soluble pine-tar creosote.....	11	73	14	86
Soluble pine-tar creosote alone.....	9	11	20	20
Paraffin and paradichlorobenzene.....	9	78	33	90
Check (untreated).....			15	7

Paradichlorobenzene dissolved in crude cottonseed oil gave excellent results which were probably due to the good spreading and penetrating power of the oil. The melted paraffin and the soluble pine-tar creosote when containing paradichlorobenzene were effective, but they did not give so good control as paradichlorobenzene dissolved in crude cottonseed oil. Crude cottonseed oil and soluble pine-tar creosote both showed some insecticidal action when used alone, apparently acting as contact insecticides. The results of these experiments were uniformly better than those of the previous fall on account of the more rapid volatilization of the paradichlorobenzene, caused by the higher temperatures prevailing during the 2-week period. The average temperature throughout the period was 69.1° F., and the maximum for each day was above 70°. No tree injury could be detected from any of the treatments.

EXPERIMENTS WITH PARADICHLOROBENZENE IN A COTTONSEED-OIL EMULSION AND DISSOLVED IN LINSEED AND CORN OILS

As the experiments of the spring of 1929 showed that paradichlorobenzene dissolved in crude cottonseed oil was a very effective and safe remedy for the lesser peach borer attacking peach trees, experiments with paradichlorobenzene-crude cottonseed oil emulsions as a spray for that insect were conducted in the fall of that year. Experiments in applying the chemical dissolved in crude cottonseed oil with a spray outfit, as compared with a paintbrush, were also conducted that fall, and solutions of paradichlorobenzene in linseed and corn oils were also tested. Table 3 gives a list of the materials tested and the results obtained.

TABLE 3.—*Results of experiments with paradichlorobenzene in emulsions and washes for the control of the lesser peach borer, Fort Valley, Ga., 1929*

Materials applied to infested areas of peach trees	Strength (first figures represent quantity of paradichlorobenzene)	Applied with—	When applied	Total number of larvae examined and the per cent found dead on examination after exposure of—									
				1 week		2 weeks		3 weeks		4 weeks		5 weeks	
				Total larvae	Per cent dead	Total larvae	Per cent dead	Total larvae	Per cent dead	Total larvae	Per cent dead	Total larvae	Per cent dead
Paradichlorobenzene— In cottonseed-oil emulsion.	1 pound, 2 quarts oil and water to make 7 gallons.	Sprayer (180 pounds pressure)	Nov. 6			74	1	50	4	108	4		
Do.	2 pounds, 2 quarts oil and water to make 7 gallons.	do.	Nov. 4			62	2	80	0	106	3		
Do.	3 pounds, 2 quarts oil and water to make 7 gallons. (Some recrystallization.)	do.	Nov. 5			109	1	109	1	40	5		
Do.	4 pounds, 4 quarts oil and water to make 7 gallons.	do.	Nov. 9			171	22	69	33	67	48		
Do.	3 pounds, 3 quarts oil and water to make 3½ gallons.	Sprayer (150 pounds pressure)	Dec. 5			134	60			63	54		
Do.	4 pounds, 4 quarts oil and water to make 3½ gallons.	do.	do.			123	59			86	62		
And crude cottonseed oil.	1 pound to 2 quarts.	Hand sprayer (could not develop enough pressure to make a spray).	Oct. 29			82	79						
Do.	do.	Sprayer (5 to 85 pounds pressure, mostly 20 pounds).	Oct. 31			88	76						
And corn oil.	do.	Sprayer (80 to 100 pounds pressure).	do.			93	81						
And crude cottonseed oil.	do.	Paintbrush.	Oct. 11	24	171	13	169	19	168	53	151	24	146
And linseed oil.	do.	do.	do.	23	161	9	156	18	161	11	136	15	160
And crude cottonseed oil.	do.	do.	Nov. 18	13	77	144	82	400	82				

¹ The live borers were found in well-sheltered and protected places in live, hard wood. Their burrows were in such a position that the larvae could not be affected by the insecticide.

The emulsions could be applied satisfactorily with a sprayer, but none of them proved to be so effective as the paradichlorobenzene-crude cottonseed oil wash for the control of the lesser peach borer. The results from the wash applied October 11 show the necessity of applying it beyond the infested areas and thoroughly soaking the parts with the insecticide. That was not done in this case, and as a result many live borers were found in the live tissue of well-sheltered and protected places around the edges of infested areas. The wash applied on November 18 was too late for best results; however, an 82 per cent control was obtained from the late application. The crude cottonseed oil wash can not be applied very satisfactorily with a sprayer on account of its high viscosity. Linseed and corn oils were only fairly satisfactory as solvents for paradichlorobenzene. The linseed oil was rather sticky, and therefore difficult to handle. Furthermore, it was thick and apparently did not penetrate and spread so well as the wash made with crude cottonseed oil. That was also an objection to corn oil. There was no tree injury from any of the treatments.

FURTHER EXPERIMENTS WITH WASHES AND EMULSIONS

During the spring of 1930 further experiments with the paradichlorobenzene-cottonseed oil wash and paradichlorobenzene-cottonseed oil emulsions were conducted to check the results previously obtained with these materials in lesser peach borer control. Table 4 gives the results of these tests.

TABLE 4.—Results of experiments with paradichlorobenzene as a wash and in emulsions for the control of the lesser peach borer, Fort Valley, Ga., 1930

Materials applied to the infested areas of peach trees	Strength	Applied with—	When applied ¹	Total number of larvae examined and the per cent found dead on examination after exposure of—					
				1 week		2 weeks		3 weeks	
				Total larvae	Per cent dead	Total larvae	Per cent dead	Total larvae	Per cent dead
Paradichlorobenzene and crude cottonseed oil wash.	1 pound paradichlorobenzene to 2 quarts oil.	Paintbrush after scraping areas.	April 2 ²	27	82	76	93	-----	-----
Paradichlorobenzene-cottonseed oil emulsion.	3 pounds paradichlorobenzene, 3 quarts oil, and water to make 3½ gallons.	Sprayer (150 pounds pressure).	April 1..	19	32	41	27	56	55
Do.....	4 pounds paradichlorobenzene, 4 quarts oil, and water to make 3½ gallons.	do.....	do.....	19	37	26	54	78	51

¹ Temperature was above 70° F. when all applications were made.

² A light rain started about 1½ hours after this application.

These results substantiate those obtained during the previous spring proving that paradichlorobenzene dissolved in crude cottonseed oil and applied with a paintbrush is very effective for the control of the lesser peach borer. The emulsion applied as a spray is not so effective against that insect as the wash. No tree injury was recorded.

COMPARATIVE EFFECTIVENESS OF PARADICHLOROBENZENE DISSOLVED IN CRUDE COTTONSEED OIL AND IN MINERAL OILS

During the fall of 1930 experiments were conducted to compare the results from crude cottonseed oil and mineral oils as solvents for paradichlorobenzene when used for the control of the lesser peach borer in peach trees. Both red and white mineral oils were tested. The paradichlorobenzene dissolved in crude cottonseed oil was applied to areas from which the gum, frass, loose bark, etc., had been removed before the application and also to areas that had received no previous preparation, to note the difference in the results. The areas on one-half of the trees were treated with the washes only to the edges of the borer indications, whereas the areas on the other half of the trees were treated with the washes well beyond the edges of the borer indications, and the areas were well soaked. Table 5 gives the results of these experiments.

TABLE 5.—*Results of experiments with paradichlorobenzene dissolved in crude cottonseed oil and in mineral oils for the control of the lesser peach borer, Fort Valley, Ga., October 14 and 15, 1930*

Materials applied ¹ to infested areas of peach trees	Applied to infested areas with a paintbrush—	Total number of larvae examined and the per cent found dead 7 to 10 days after treatment	
		Total larvae	Per cent dead
Paradichlorobenzene and crude cottonseed oil.	Only to edges of borer indications.....	83	84
Do.....	Well beyond the edges of borer indications and soaked.	79	85
Total or average.....		162	85
Paradichlorobenzene and crude cottonseed oil.	Beyond the edges of borer indications ²	235	80
Paradichlorobenzene and red mineral oil (viscosity at 100° F., 105 seconds Saybolt).	Only to edges of borer indications.....	208	71
Do.....	Well beyond the edges of borer indications and soaked.	219	85
Total or average.....		427	78
Paradichlorobenzene and white mineral oil (viscosity at 100° F., 79 seconds Saybolt).	Only to edges of borer indications.....	167	70
Do.....	Well beyond the edges of borer indications and soaked.	128	87
Total or average.....		¹ 295	² 77

¹ In each case at 1 pound of paradichlorobenzene to 2 quarts of oil.

² Gum, frass, loose bark, etc., removed before each area was treated.

Removal of gum, frass, loose bark, etc., from infested areas before treatment did not improve the results from the wash, although some borers were killed by the instrument when scraping the areas. The number of borers killed by the instrument was not recorded. The control where areas were prepared before treatment was really lower than where no previous attention had been given. Where the areas were scraped a number of the borers were run out of their burrows by

the treatment and died on the outside. Some of these probably fell off of the limbs to the ground and were therefore not recorded when the examinations were made. The gum, frass, and loose bark apparently hold the wash on the infested areas, and should therefore be left on.

Crude cottonseed oil is a more suitable solvent for paradichlorobenzene than mineral oils when used for the lesser peach borer. Both the white and red mineral-oil washes possess excellent spreading and penetrating qualities, and were satisfactory when they were applied beyond the edges of borer indications and the areas soaked, but when applied only as far as the edges of borer indications in infested areas they were not so effective against the lesser peach borer as the crude cottonseed-oil wash.

It is likely that some tiny borers were killed by the various treatments but could not be seen when the examinations were made. Hence the number of borers dead from the several treatments is perhaps larger than that actually recorded. The check trees contained an average of 13.5 borers per tree, whereas the average number found in the treated trees was 10.08 per tree. Those figures indicate that some borers from the treated trees were not recorded. Either they had become decomposed or were too small to be seen when the examinations were made. There was no tree injury from any of the treatments.

CHANGES IN WASH AND EMULSION DURING STORAGE

Paradichlorobenzene dissolved in crude cottonseed oil in the proportion of 1 pound of the chemical to 2 quarts of oil, and paradichlorobenzene-cottonseed oil emulsion made from 2 pounds of paradichlorobenzene, 2 quarts of cottonseed oil, and water to make 7 gallons were stored during the fall of 1929 for the purpose of noting the chemical and physical changes during the winter. The changes recorded are given in Table 6.

TABLE 6.—*Change in solutions of paradichlorobenzene in cottonseed oil and paradichlorobenzene-cottonseed oil emulsion during storage, Fort Valley, Ga., 1929–30*

[Two jars, each with one-half pound of paradichlorobenzene dissolved in 1 quart of cottonseed oil, placed in storage on Nov. 19, 1929. Net weight of each lot 1,042 grams]

Date of observation	Change in weight				Condition of insecticide
	Jar closed to air		Jar open to air		
	Weight	Loss	Weight	Loss	
1929	Grams	Grams	Grams	Grams	
Nov. 20					A few crystals in bottom of jars.
Dec. 2					Many crystals in bottom of jars (weather cold).
Dec. 11					Majority of crystals have disappeared owing to warm weather.
Dec. 20					Considerable recrystallization has taken place in bottom of jars.
1930					
Feb. 20	1,042	0	974	68	(Crystals entirely disappear in warm weather.)
Mar. 22	1,042	0	950	92	
Apr. 24	1,042	0	920	122	
July 10	1,042	0	866	176	

Paradichlorobenzene-cottonseed oil emulsion, made from 2 pounds paradichlorobenzene, 2 quarts of crude cottonseed oil, and water to make 7 gallons, was placed in storage in an open container on November 20. Notes on its condition were made as follows:

Date of observation	Condition of insecticide
Nov. 26----	Recrystallization of paradichlorobenzene has taken place.
Nov. 27----	Few oil globules have appeared on surface.
Dec. 11----	Surface of emulsion covered with oil globules. It is breaking down.

Evidently the paradichlorobenzene-cottonseed oil wash can be stored in containers closed to the air without any loss of the chemical. There was no loss in weight of the wash stored for about eight months in a jar closed to the air, but there was a loss of 176 grams by July 10 from 1,042 grams of the wash that was stored in an open container on November 19. This loss was largely that of the active chemical. Recrystallization in the wash takes place during cold weather, but the crystals disappear again with warm weather.

The paradichlorobenzene-cottonseed oil emulsion held up for about three weeks when stored in an open container.

The comparative evaporation of paradichlorobenzene from cottonseed and mineral oils was found by the insecticide division of the Bureau of Chemistry and Soils to be as shown in Table 7.

TABLE 7.—*Evaporation of paradichlorobenzene from cottonseed and mineral oils*

Oil	Viscosity at 100° F. (Saybolt)	Retention of paradichlorobenzene (10 per cent solution)		
		Exposed at 100° F.		Exposed at room temper- ature (75° to 80° F.) 4 days
		1 day	3 days	
	Seconds	Per cent	Per cent	Per cent
Cottonseed oil.....	186	1.95	0.91	0.70
White mineral oil.....	79	1.34	.18	.21
Red mineral oil.....	105	.98	.18	.19

The evaporation of paradichlorobenzene from the mineral oils was more rapid than from cottonseed oil, and that may account for the differences in toxicity observed when a solution of paradichlorobenzene in cottonseed oil was compared with solutions of paradichlorobenzene in mineral oils for the control of the lesser peach borer.

RECOMMENDATIONS

As a result of the work reported upon in this circular, paradichlorobenzene dissolved in crude cottonseed oil is recommended for the control of the lesser peach borer. It should be used in the proportion of 1 pound of paradichlorobenzene to 2 quarts of crude cottonseed oil and applied to the infested areas with a paintbrush. (Fig. 2.) Treatment should extend for a few inches beyond the edges of borer indications, and the areas should be thoroughly soaked with the insecticide. Only infested areas should be treated. The insecti-

cide should not be used over the entire trunk or limbs or on healthy tissue at places other than on borders of infested areas. The oil may have to be warmed a little in cold weather to dissolve all the crystals. Applications should be made either in the fall or the spring. Applications in April may give a little better control than those made in October, but spring applications permit the borers to work in the



FIGURE 2.—Applying paradichlorobenzene dissolved in crude cottonseed oil for lesser peach borer control

trees during the fall and the warm periods of the winter. It is not necessary to remove the gum, frass, or loose bark from infested areas before applying the wash.

SUMMARY

Materials for the control of the lesser peach borer which must be applied hot are not practical for use in commercial peach orchards.

Paradichlorobenzene dissolved in crude cottonseed oil in the proportion of 1 pound of the chemical to 2 quarts of oil proved to be more effective against the lesser peach borer than any of the other

materials tested. It gave from 93.4 to 97.9 per cent control when applied about April 1.

Emulsions of paradichlorobenzene and crude cottonseed oil applied as a spray are not so effective against the lesser peach borer as the same chemical dissolved in crude cottonseed oil and applied with a paintbrush. For best results the wash must be applied well beyond the edges of borer indications, and the areas must be thoroughly soaked. The wash can not be applied very satisfactorily with a sprayer.

Linseed and corn oils are not as satisfactory as cottonseed oil for use with paradichlorobenzene, as they are thicker and the linseed oil is sticky.

Crude cottonseed oil is a more suitable solvent for paradichlorobenzene than mineral oils when used for lesser peach borer control.

Removal of gum, frass, loose bark, etc., from infested areas before treatment did not improve the results from the paradichlorobenzene-cottonseed oil wash.

There was no discernible injury to peach trees from any of the treatments tested on areas infested by the lesser peach borer.

If the paradichlorobenzene-cottonseed oil wash is stored it should be placed in a tight container so as to close it entirely to the air. Recrystallization will take place with cold weather, but the crystals will disappear again with warm weather.

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